CAISO 33% RPS Operational Study

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ARB RES Workshop
December 14, 2009

Overview of Presentation

- Objectives of ISO Operational Study – Phase 1 and 2
- Overview of Inputs and Study Limitations
- Status and Schedule

Overview of 33% RPS Operational Study

- Simulates the California power system in 2020 under alternative CPUC 33% RPS renewable generation scenarios
  - Reference Case
  - High Wind Case
  - High Distributed Generation Case
  - High Imports Case
  - 20% Reference Case
  - All Gas Case
- Two Phases
  - First Phase underway
    - Step 1 - Simulation of renewable integration operational requirements
    - Step 2 - Production simulation with WECC zonal transmission network model
  - Second Phase in Spring 2010

Phase 1- Step 1: Assesses Intra-Hour Operational Requirements

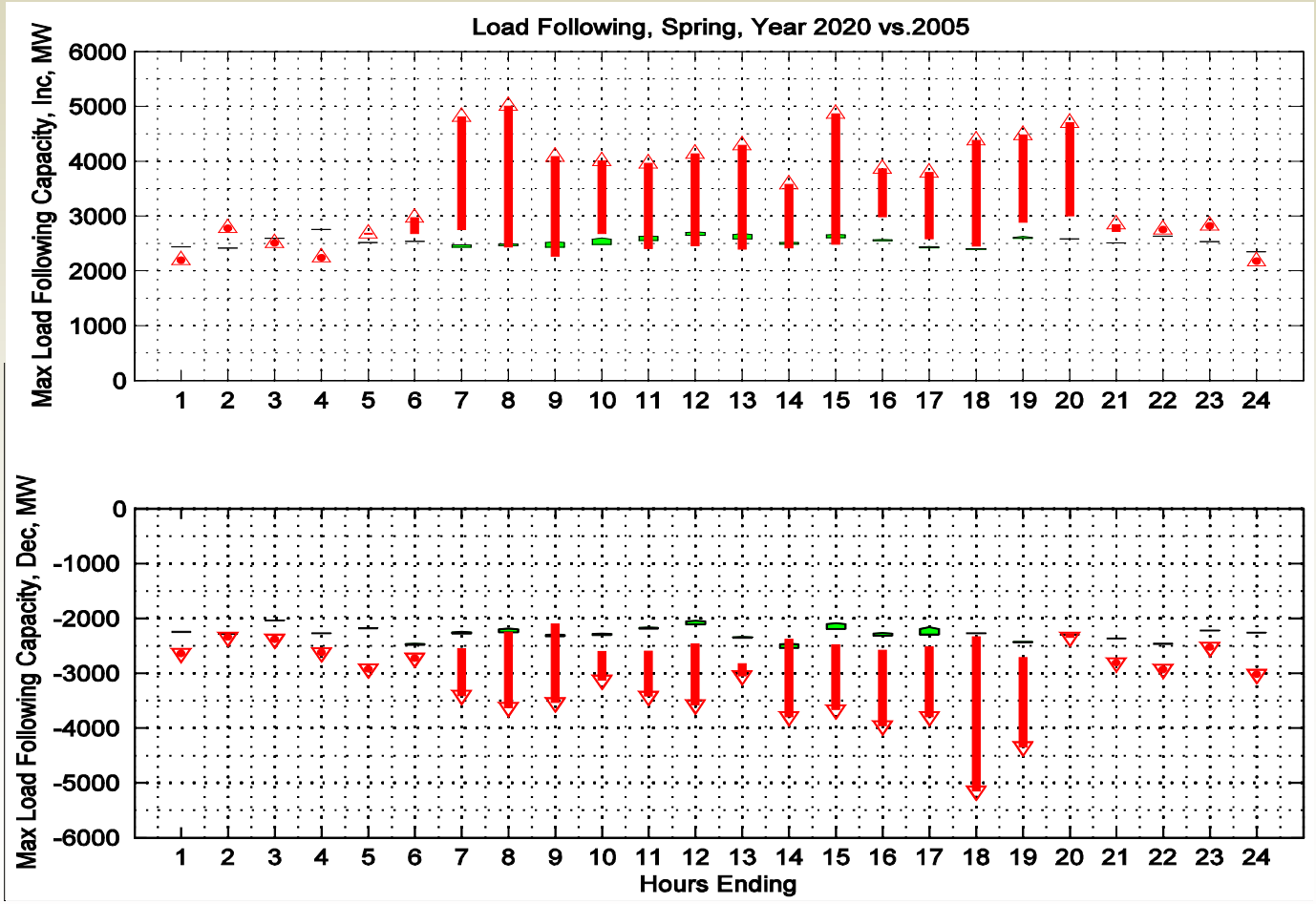
- Estimates added intra-hour production variability under each studied renewable portfolio
- Calculates the following:
  - Regulation Up and Regulation Down capacity and ramp requirements by hour and season
  - Load-following capacity requirements by hour and season
  - Generic ramp rate requirements by hour and season
- Isolates the contribution to system variability of load, wind resources and solar resources.
- Methodology originally used in ISO 2007 study, now updated
- Required intensive development of 1-min load, wind and solar profiles

Example of changes in five minute economic dispatch/load following capacity for 33% reference case

[results are preliminary and not to be relied upon]

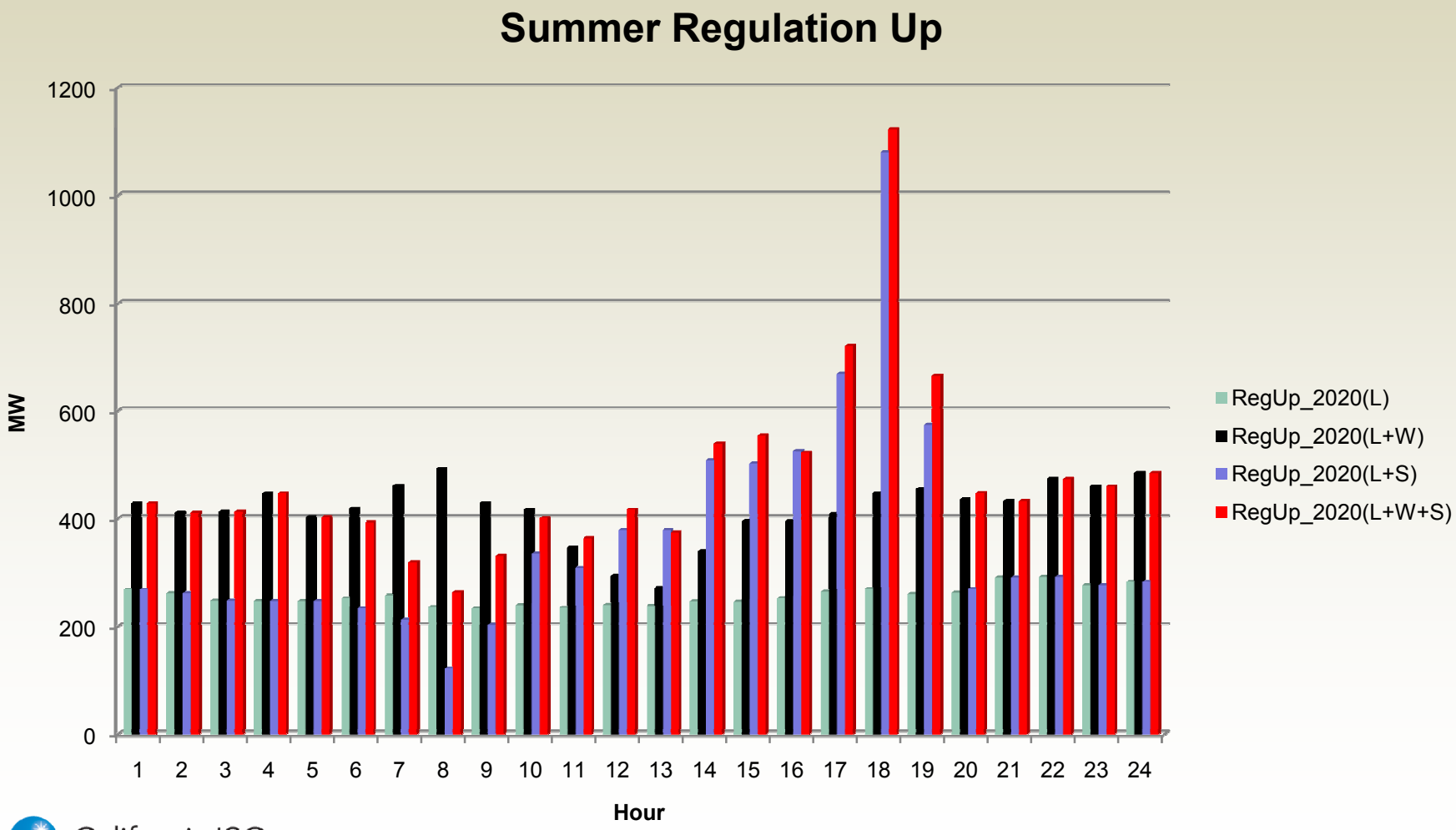
Maximum upward increase from 2500 MW to 5100 MW in HE 8.

Maximum downward decrease from 2100 MW to 5200 MW in HE 18.



Regulation Requirements for 33% Reference Case

[results are preliminary and not to be relied upon]



Phase 1 – Step 2: Production Simulation

- Dynamic optimization model that simulates the power system using least-cost commitment and dispatch of resources to meet load in an hourly time-step
- For each renewable portfolio it will determine:
  - Integration costs measured in changes in production costs ($/MWh) between a benchmark scenario and alternative renewable/load scenarios
  - Fixed costs of additional conventional generation needed to integrate renewables
  - Hours of congestion for CA paths modeled (inter-bubble transmission and Path 15)
  - GHG emissions
  - Ramp and capacity constraint violations/overgeneration results by bubble, by month and day, before and after addressing violations
  - Natural Gas usage in CA for power generation for the year

Core Inputs to Model

- Supply
  - CPUC Renewable Scenarios
  - Anticipated new conventional resources
  - Additional conventional resources to achieve PRM
  - Demand Response
- Ancillary Services requirements -- Regulation (from Step 1) and Operating Reserves
- Transmission Network
- Demand (Load) – CEC September Updated High Load Case
- Environmental emissions factors (GHG)

Transmission Modeling Assumptions

- California state-wide system modeled
  - PG&E Valley
  - PG&E Bay
  - SMUD
  - SCE
  - SDG&E
  - LADWP
  - IID
  - TID
- Rest of WECC

Generation Operating Characteristics

- Generic generation data (Pmin, Pmax; Min. up- and down time; Ramp rates; Ancillary Service Ranges); checked by CAISO for existing generation units against confidential Master File data for consistency
- California hourly hydro generation and AS contribution is based on data obtained from IOUs
- Renewable resources assumed to be fixed output profiles (not dispatchable)
  - Second phase will modify this assumption

Constraint Violations Evaluated in Production Simulation

1. Regulation-Up
2. Regulation-Down
3. Spin
4. Non-Spin
5. Unserved Energy
6. Over-generation

* *Either insufficient ramping capability or insufficient available capacity results in one of the above violations. Exact penalty costs in optimization to be determined.*

This study is not examining a range of operational, reliability and transmission requirements and costs

- Transmission Build-out
  - Only minimal adjustments to transmission capacity in operational study; no calculation of realistic 33% RPS transmission costs (see, e.g., ISO regional transmission studies)
- Operational/Transmission Planning
  - No consideration of commitment or dispatch uncertainty, i.e., forecast error in the production cost simulation
  - No intra-hour modeling of operations
  - No evaluation of intertial requirements needed to withstand contingencies
  - No evaluation of system harmonics, transient or post-transient stability

Consideration of these elements will tend to increase the need for integration capacity with likely increase in costs and emissions levels

Second Phase – 33 % Operational Study

- Focuses on quantifying impacts of alternative solutions to mitigating variability and possible study refinements
  - Demand response
  - Solar defocusing
  - Feathering wind resources
  - Storage
- Will provide further insight into:
  - Changes in operational requirements
  - Changes in production costs
  - Changes in GHG emissions
  - Changes in capital costs (off-line calculation)

Study is conducted through a collaborative working group.

- Core Study Team (Phase 1) – responsible for doing the work
  - ISO – study design, assumptions and outputs
  - CPUC – study design, assumptions and outputs
  - SCE – primary modeling responsibility
  - Nexant – project management and resource profiling
- Working Group – represents a cross-section of industry and provides input on methodology, assumptions and outputs through weekly calls
  - CEC
  - PG&E
  - WPTF
  - TURN
  - Large Scale Solar Association
  - CalWEA
- Other Public forums – ISO will hold at least two “stakeholder” meetings to discuss preliminary and final results

Schedule and Status

- Phase 1
  - Step 1 results complete by Dec. 18th
  - Step 2 model setup complete
  - Step 2 modeling completed by mid-January 2010
  - ISO finalizes results by early February 2010
  - ISO prepares report by Spring 2010
- Phase 2 modeling begins in Spring 2010